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Ogushi et al.

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(54) **REMOTE MAINTENANCE SYSTEM**

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(52) **U.S. Cl.** **700/110**; 700/109; 700/121
(58) **Field of Search** 702/184, 188; 700/108–111, 113, 79–80, 67, 174, 2–3, 121

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,390,953	A	*	6/1983	Johnstone 364/474.19
4,517,468	A	*	5/1985	Kemper et al. 290/52
5,212,645	A		5/1993	Wildes et al. 364/463
5,225,997	A	*	7/1993	Lederer et al. ..... 702/188 X
5,245,554	A	*	9/1993	Tsuyama et al. 702/185
5,315,711	A		5/1994	Barone et al. 395/275
5,383,113	A		1/1995	Kight et al. 705/40
5,432,715	A	*	7/1995	Shigematsu et al. .... 364/132 X
5,483,530	A		1/1996	Davis et al. 370/465
5,544,320	A		8/1996	Konrad 395/200.09
5,591,299	A	*	1/1997	Seaton et al. 700/121
5,594,663	A	*	1/1997	Messaros et al. 700/121
5,694,325	A	*	12/1997	Fukuda et al. 364/468.28
5,696,901	A		12/1997	Konrad 395/200.09
5,724,511	A	*	3/1998	Moritomo 709/245
5,726,920	A	*	3/1998	Chen et al. 702/108
5,761,064	A	*	6/1998	La et al. 364/468.17
5,923,247	A	*	7/1999	Dowden et al. 340/506
5,950,150	A	*	9/1999	Lloyd et al. 702/183
5,951,611	A	*	9/1999	La Pierre 701/29
5,963,444	A	*	10/1999	Shidara et al. 700/7
5,974,444	A		10/1999	Konrad 709/203
5,984,498	A	*	11/1999	Lem et al. 700/2

FOREIGN PATENT DOCUMENTS

DE	19506764	8/1995
EP	0051861	5/1982
FR	2688643	9/1993
JP	5-73745	3/1993
JP	8-161200	6/1996

* cited by examiner

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(74) *Attorney, Agent, or Firm*—Fitzpatrick Cella Harper & Scinto

(57) **ABSTRACT**

Factories **(102–104)** have host computers **(107)** for monitoring industrial equipments **(106)**. Each host computer **(107)** is connected to a management host computer **(108)** on a vendor **(101)** side through the internet **(105)**. The host computer **(107)** on the factory side detects occurrence of a trouble of the industrial equipment **(106)** and notifies the vendor side of status information representing a trouble state. In response to this, the host computer **(108)** on the vendor side notifies the factory side of response information representing a countermeasure against the trouble state.

82 Claims, 9 Drawing Sheets

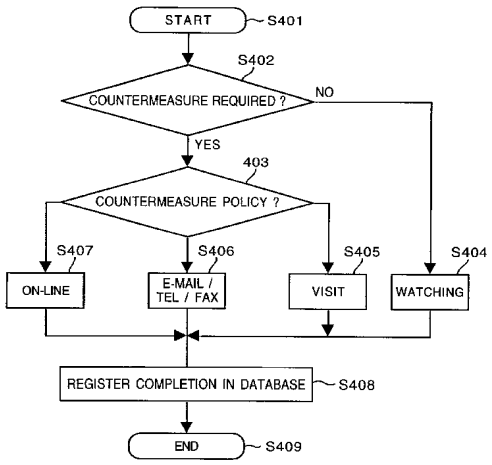


FIG. 1

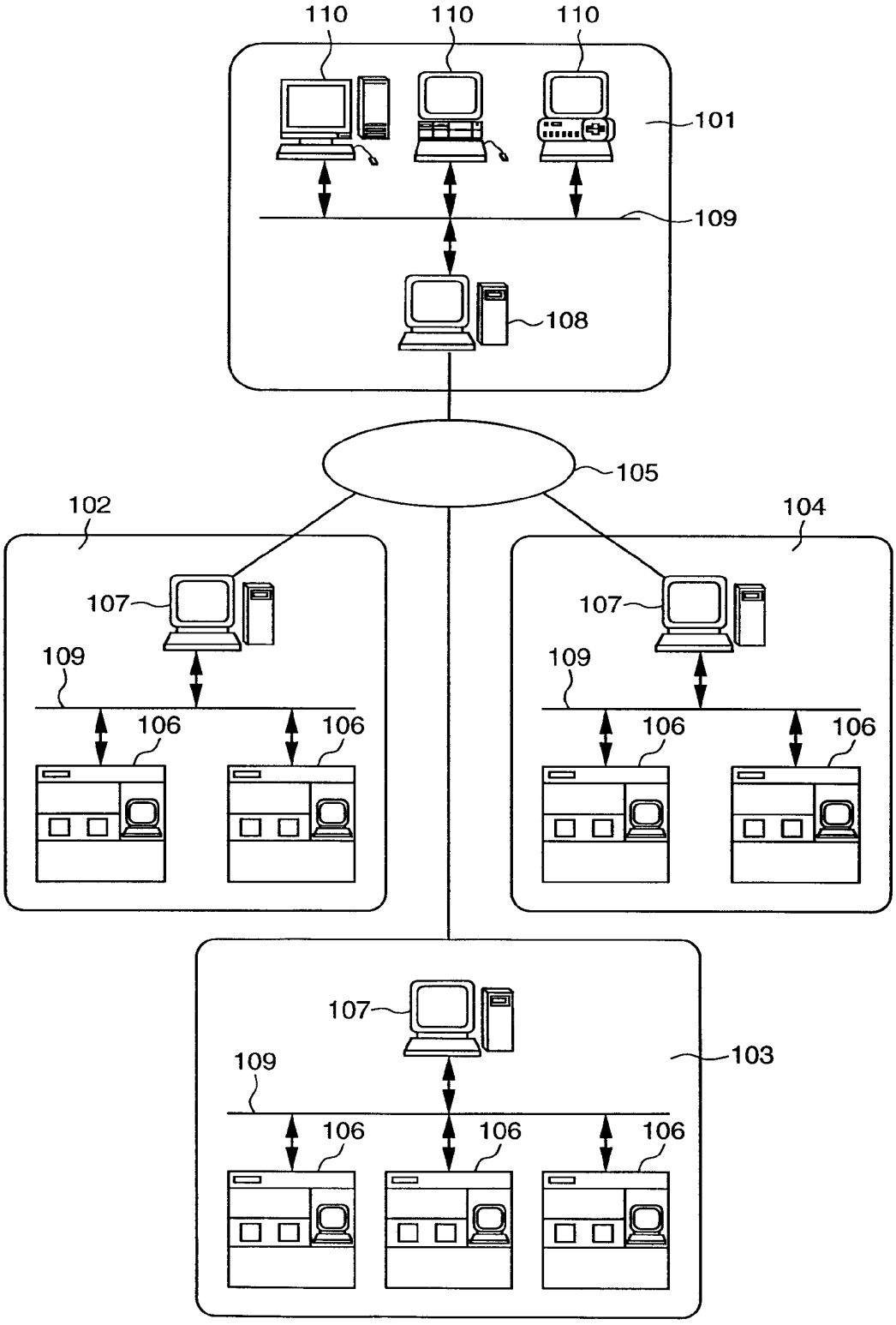

110
110
110
101
109
108
105
102
104
107
109
106
106
107
109
106
106
107
109
103
106
106
106

FIG. 2

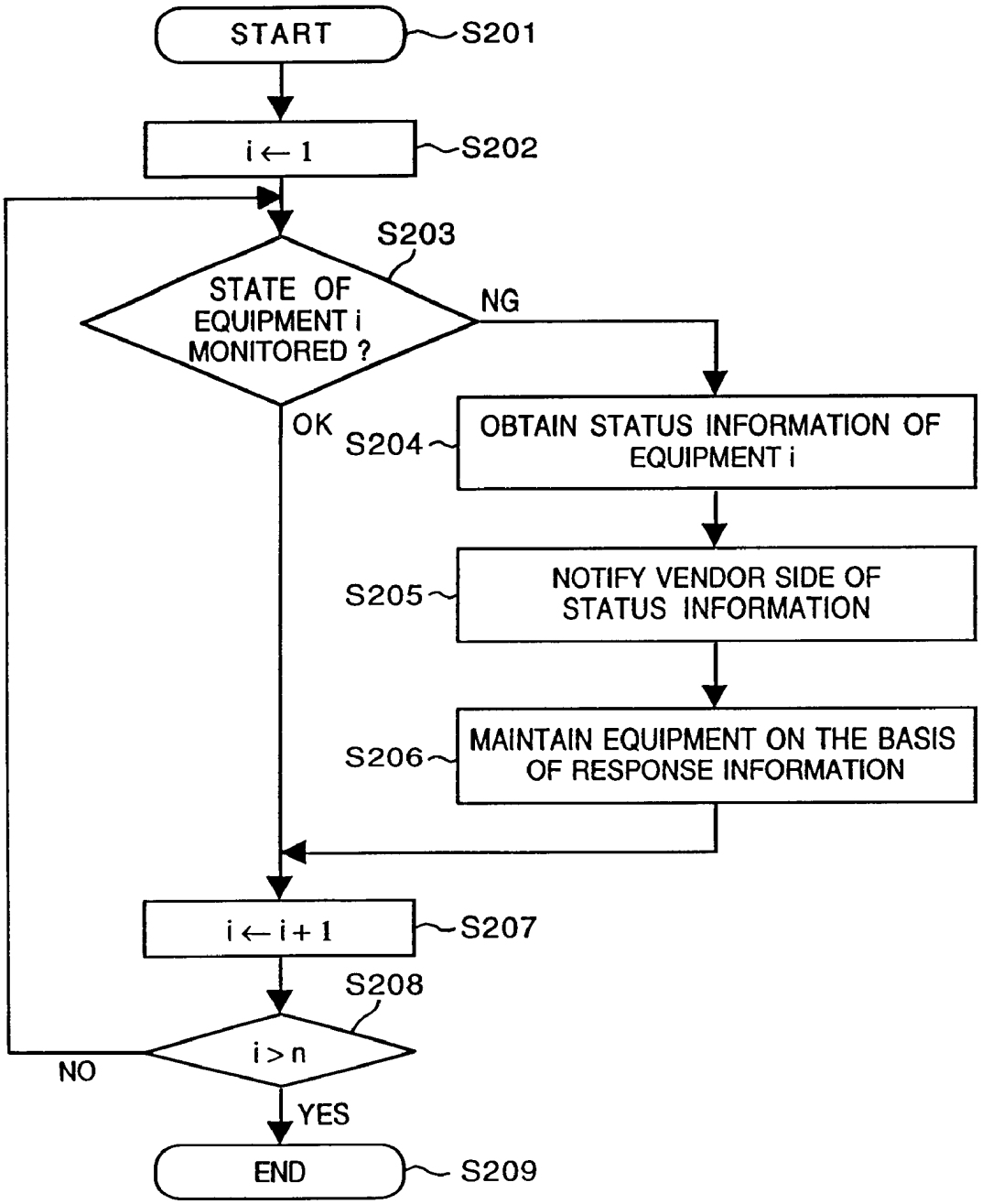

START
S201
i ← 1
S202
S203
STATE OF EQUIPMENT i MONITORED ?
NG
OK
S204
OBTAIN STATUS INFORMATION OF EQUIPMENT i
S205
NOTIFY VENDOR SIDE OF STATUS INFORMATION
S206
MAINTAIN EQUIPMENT ON THE BASIS OF RESPONSE INFORMATION
i ← i + 1
S207
S208
i > n
NO
YES
END
S209

FIG. 3

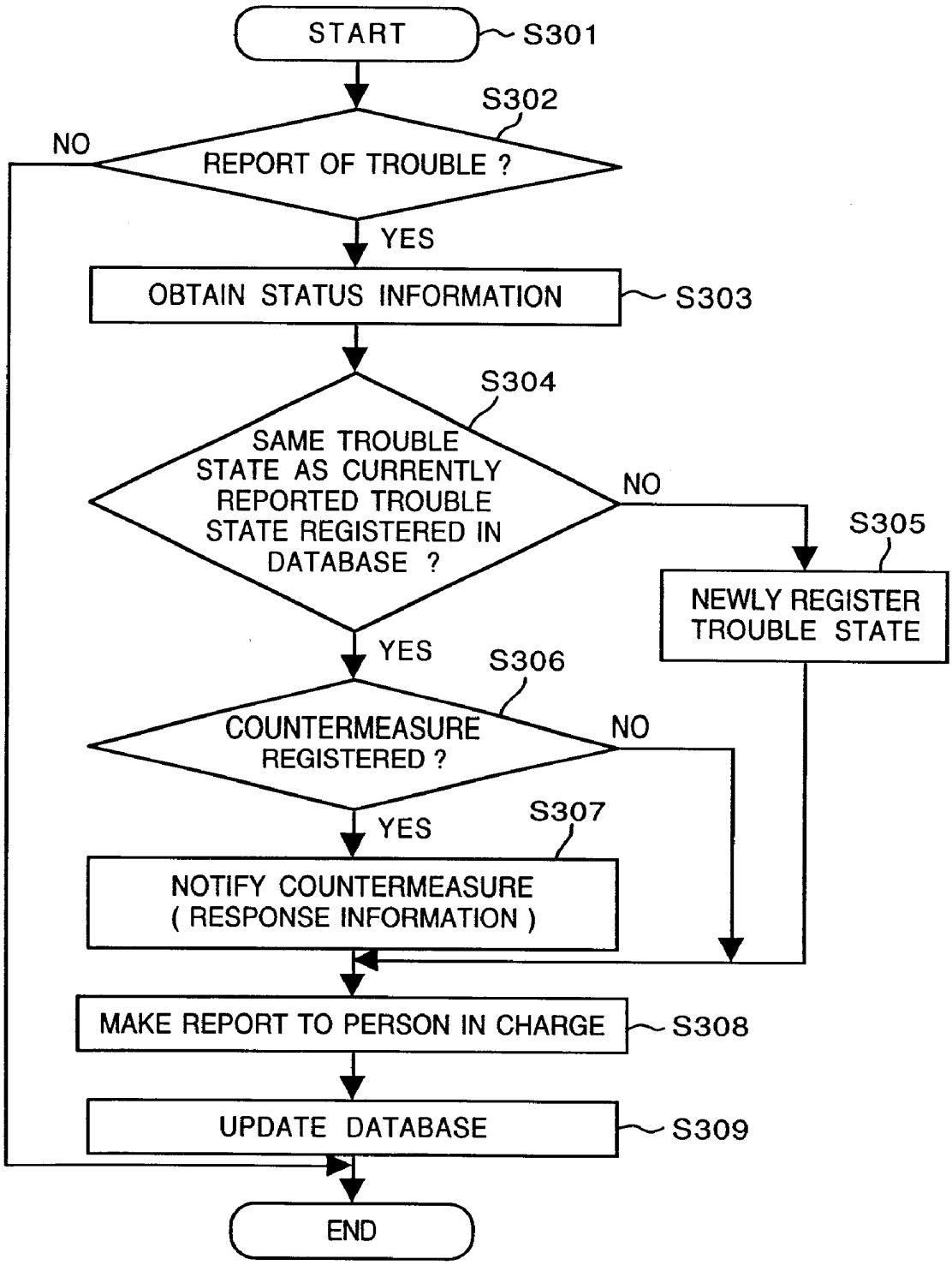

START
S301
S302
NO
REPORT OF TROUBLE ?
YES
OBTAIN STATUS INFORMATION
S303
S304
SAME TROUBLE STATE AS CURRENTLY REPORTED TROUBLE STATE REGISTERED IN DATABASE ?
NO
S305
NEWLY REGISTER TROUBLE STATE
YES
S306
COUNTERMEASURE REGISTERED ?
NO
YES
S307
NOTIFY COUNTERMEASURE (RESPONSE INFORMATION)
MAKE REPORT TO PERSON IN CHARGE
S308
UPDATE DATABASE
S309
END

FIG. 4

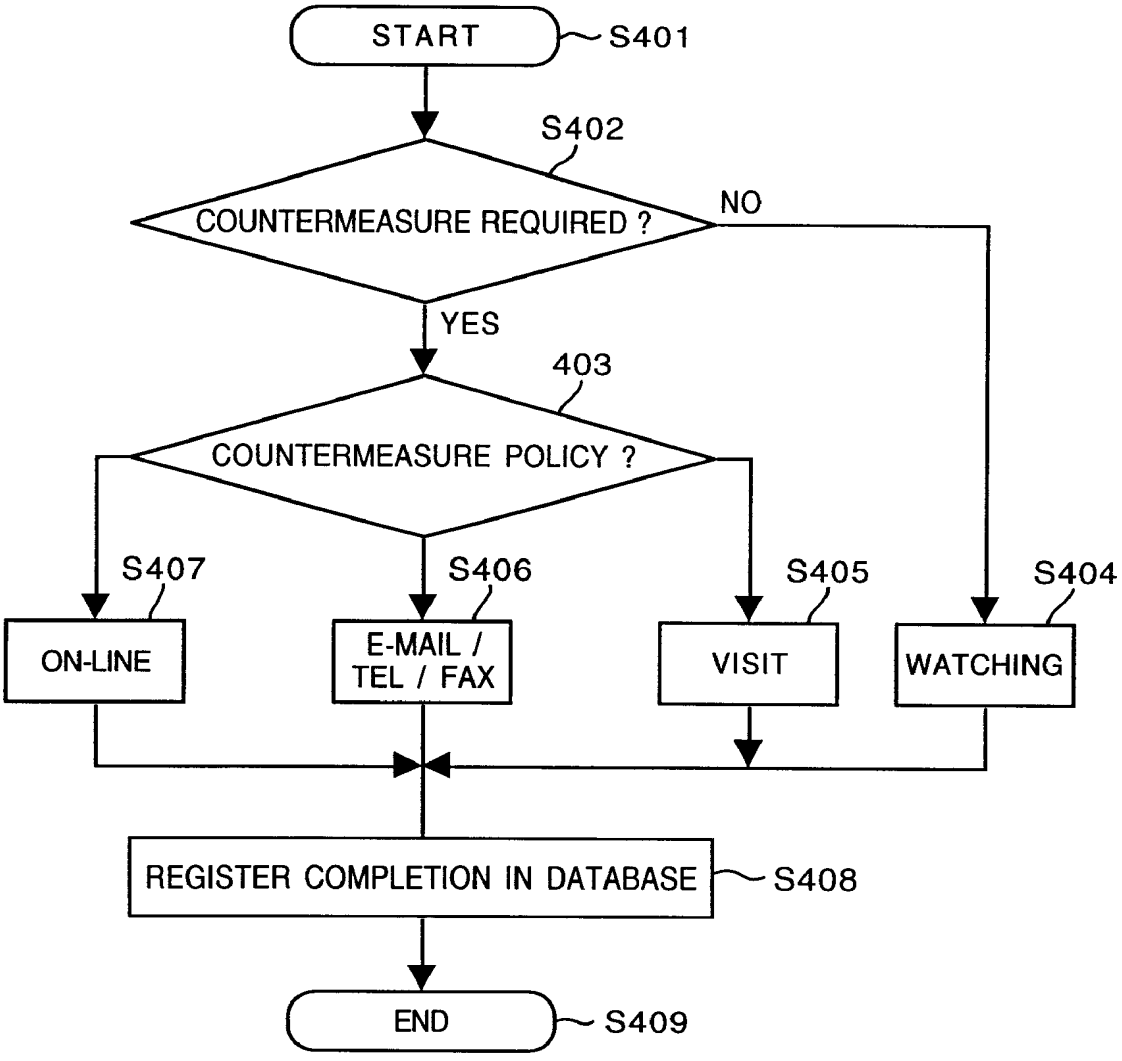

START
S401
S402
COUNTERMEASURE REQUIRED ?
NO
YES
403
COUNTERMEASURE POLICY ?
S407
S406
S405
S404
ON-LINE
E-MAIL / TEL / FAX
VISIT
WATCHING
REGISTER COMPLETION IN DATABASE
S408
END
S409

FIG. 5

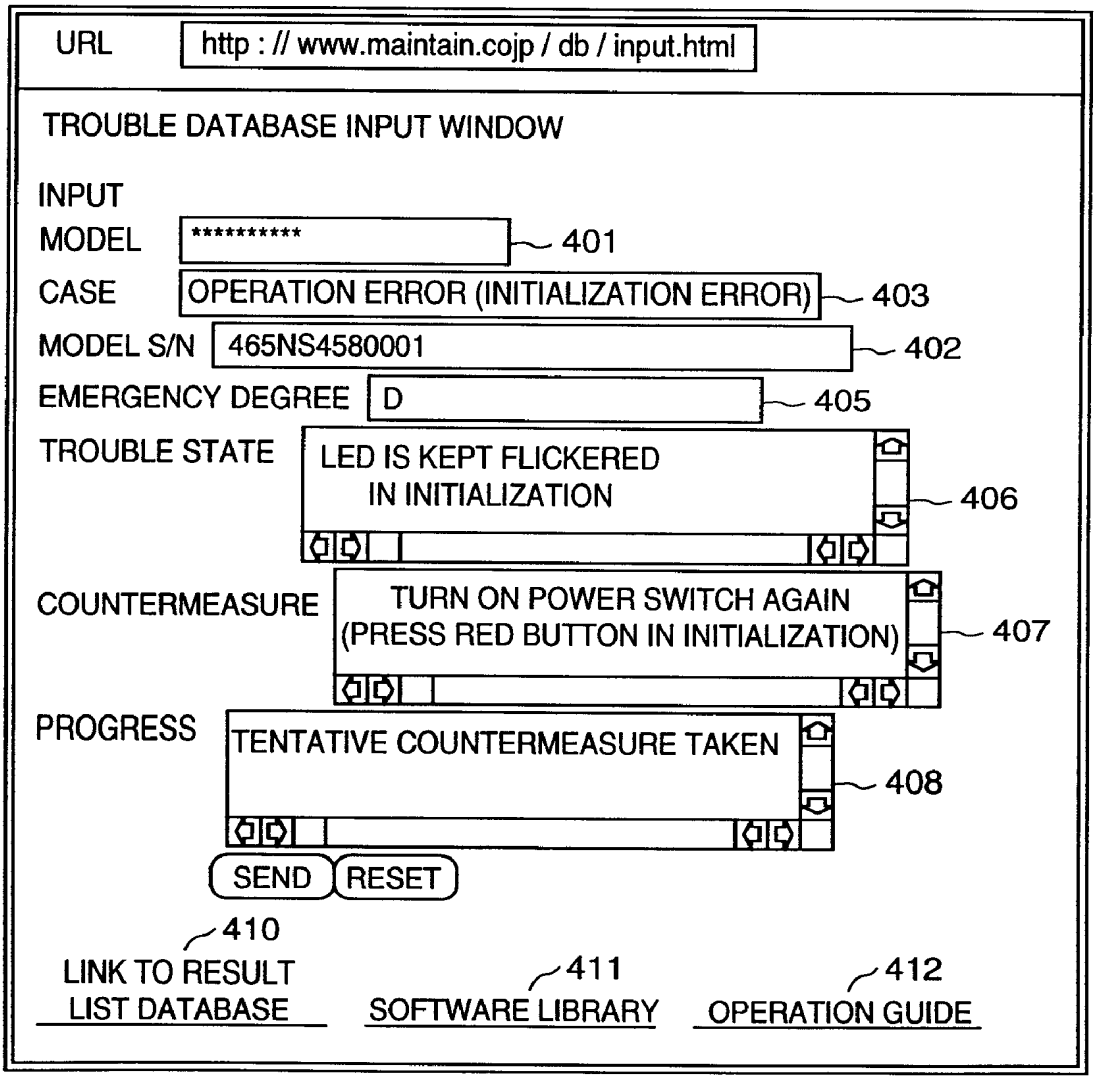

URL
http : // www.maintain.cojp / db / input.html
TROUBLE DATABASE INPUT WINDOW
INPUT
MODEL
****
401
CASE
OPERATION ERROR (INITIALIZATION ERROR)
403
MODEL S/N
465NS4580001
402
EMERGENCY DEGREE
D
405
TROUBLE STATE
LED IS KEPT FLICKERED IN INITIALIZATION
406
COUNTERMEASURE
TURN ON POWER SWITCH AGAIN (PRESS RED BUTTON IN INITIALIZATION)
407
PROGRESS
TENTATIVE COUNTERMEASURE TAKEN
408
SEND
RESET
410
LINK TO RESULT LIST DATABASE
411
SOFTWARE LIBRARY
412
OPERATION GUIDE

FIG. 6

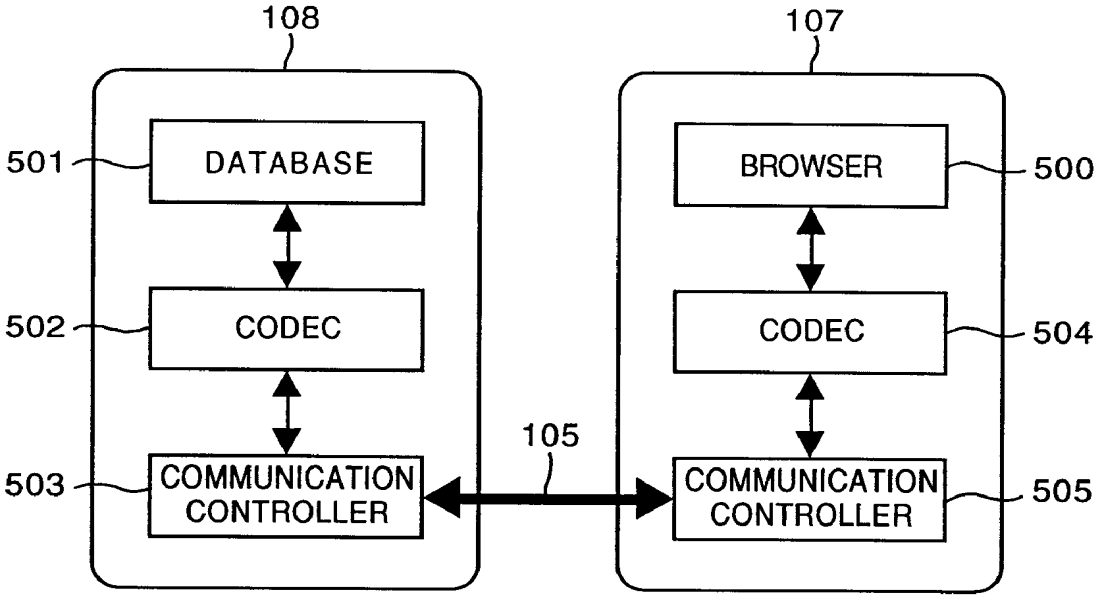

108
107
501
DATABASE
BROWSER
500
502
CODEC
CODEC
504
105
503
COMMUNICATION CONTROLLER
COMMUNICATION CONTROLLER
505

FIG. 7

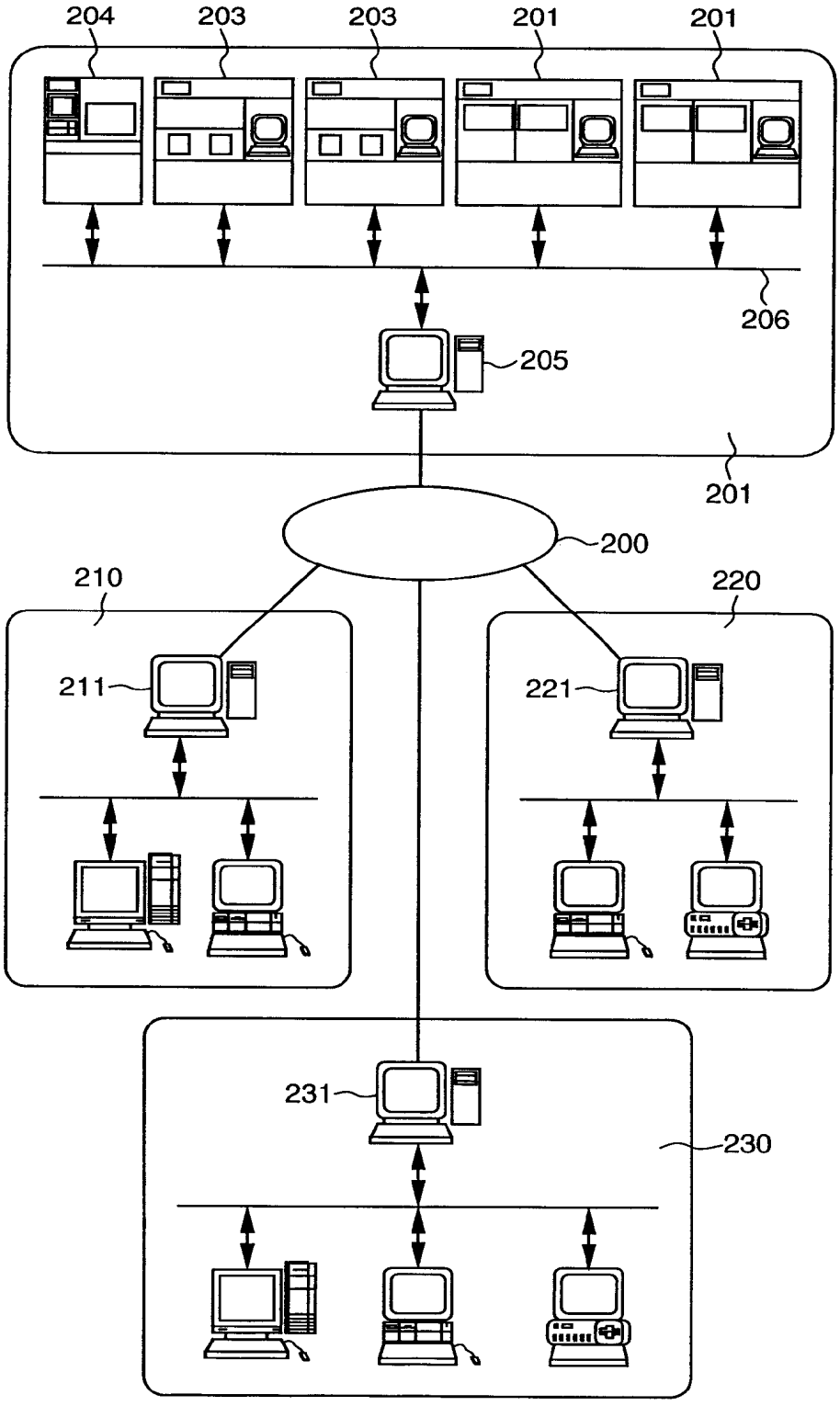


FIG. 8

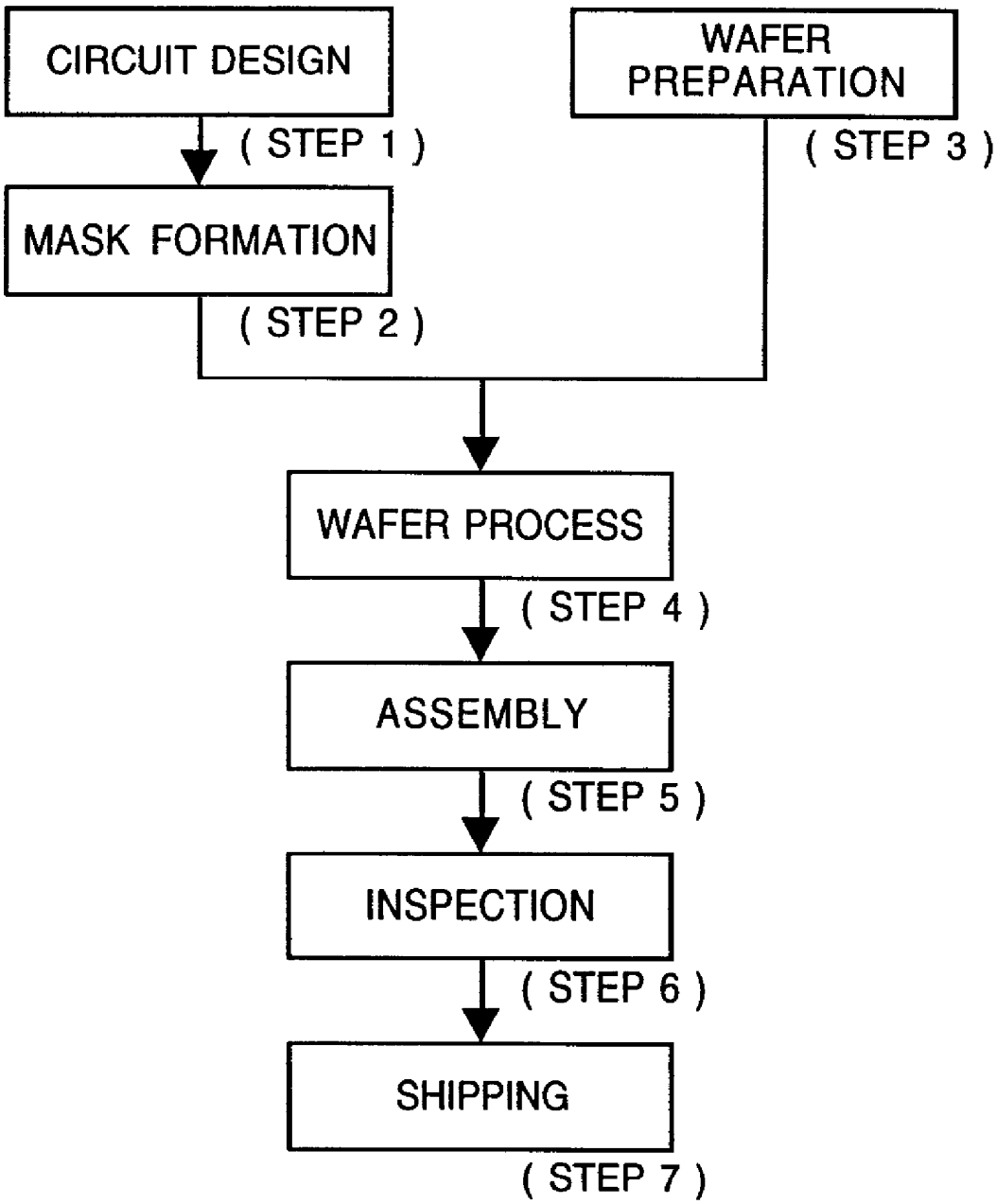
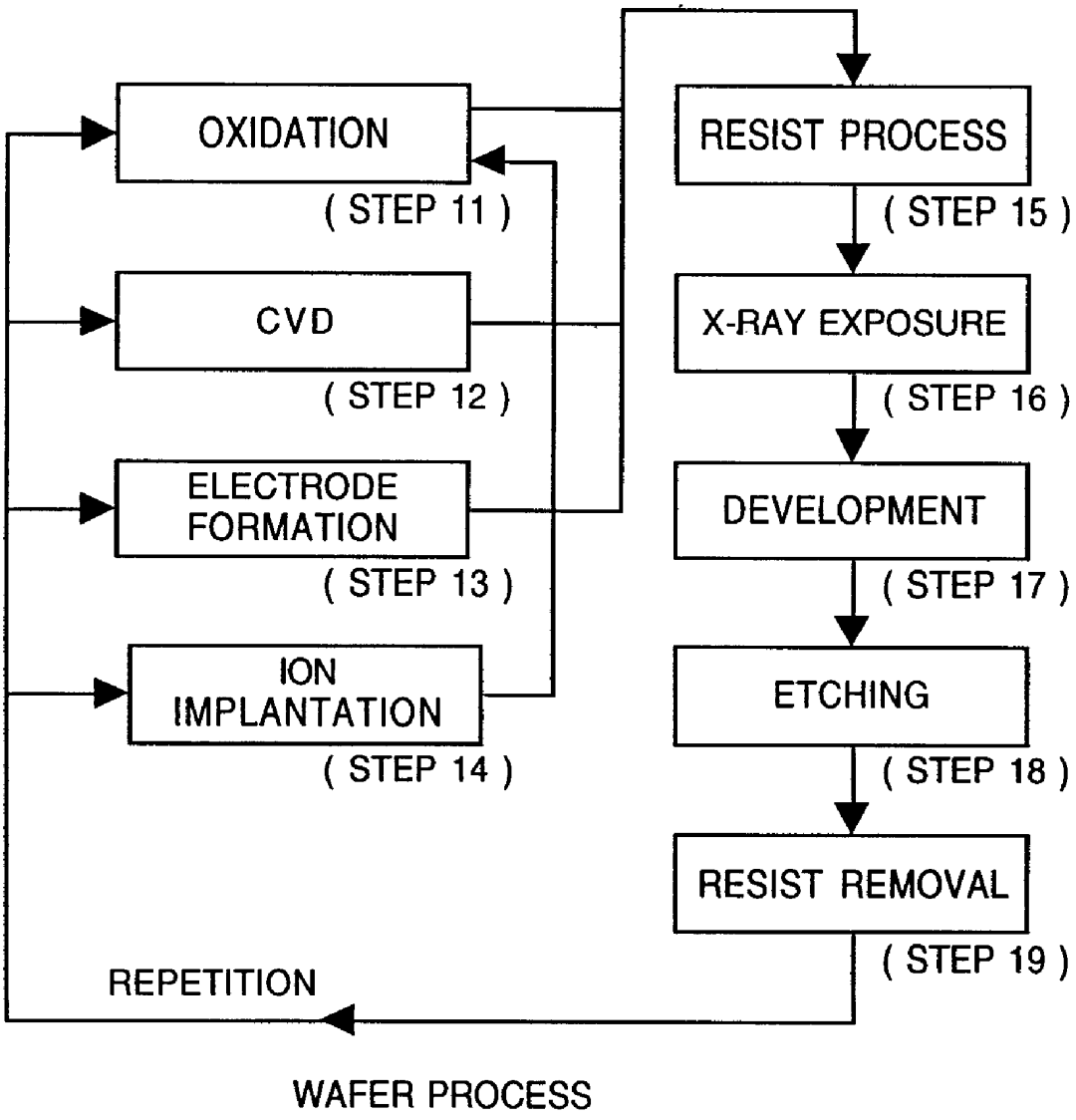

CIRCUIT DESIGN
(STEP 1)
MASK FORMATION
(STEP 2)
WAFER PREPARATION
(STEP 3)
WAFER PROCESS
(STEP 4)
ASSEMBLY
(STEP 5)
INSPECTION
(STEP 6)
SHIPPING
(STEP 7)

FIG. 9


OXIDATION
(STEP 11)
CVD
(STEP 12)
ELECTRODE FORMATION
(STEP 13)
ION IMPLANTATION
(STEP 14)
RESIST PROCESS
(STEP 15)
X-RAY EXPOSURE
(STEP 16)
DEVELOPMENT
(STEP 17)
ETCHING
(STEP 18)
RESIST REMOVAL
(STEP 19)
REPETITION
WAFER PROCESS

REMOTE MAINTENANCE SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to a remote maintenance system for maintaining an industrial equipment installed at a remote location.

Maintenance against a trouble in an industrial equipment requiring maintenance, such as a semiconductor device manufacturing apparatus has been made such that, upon occurrence of a trouble, maintenance personnel instruct a countermeasure to an operator for the manufacturing apparatus through telephone or facsimile communication or directly visit a factory where the manufacturing apparatus is installed. This also applies to periodical maintenance.

Along with recent increases in investment in the semiconductor industries, the number of installed production equipments increases to cause a chronic shortage in maintenance personnel. To achieve a low cost, production sites have been distributed at domestic and foreign remote locations. Under these circumstances, it becomes more difficult to provide countermeasures against troubles and periodic maintenance. The distributed production locations result in distribution of information about maintenance of manufacturing apparatuses. This makes it difficult to perform centralized management of information. The experiences of past troubles cannot be effectively utilized.

SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above situation, and has as its object to immediately and efficiently perform maintenance of industrial equipments installed at remote locations.

According to the present invention, the foregoing object is attained by providing a remote maintenance system for maintaining an industrial equipment installed at a remote location, the system comprising monitor means for monitoring an operating state of one or a plurality of industrial equipments, and management means for managing maintenance of the industrial equipment while communicating information associated with maintenance of the industrial equipment with the monitor means through the internet.

Another aspect is attained by providing a monitor apparatus arranged on an industrial equipment side to constitute a remote maintenance system for maintaining an industrial equipment installed at a remote location, comprising, obtaining means for detecting occurrence of a trouble of one or a plurality of industrial equipments and obtaining status information representing a state of the trouble, and communication means for notifying, through the internet, a management apparatus for performing centralized maintenance management of the industrial equipment of status information obtained by the obtaining means, and for receiving response information sent from the management apparatus through the internet in response to notification of the status information.

In another aspect of the present invention, the foregoing object is attained by providing a management apparatus arranged on a vendor side to constitute a remote maintenance system for maintaining an industrial equipment installed at a remote location, comprising, communication means for communicating, through the internet, with each monitor means of at least one factory in which a monitor apparatus is arranged to monitor an operating state of at least one industrial equipment, and corresponding means for determining a countermeasure against a trouble on the basis of status information associated with a state of the trouble of the industrial equipment, which is received by the communication means from the monitor apparatus, and causing the communication means to notify the corresponding monitor apparatus of response information based on the determined countermeasure.

In still another aspect of the present invention, the foregoing object is attained by providing a remote maintenance method of maintaining an industrial equipment installed at a remote location, comprising the steps of, communicating, through the internet, maintenance information between a first vendor for supplying a first industrial equipment, a second vendor for supplying a second industrial equipment, a first factory in which the first and second industrial equipments are installed, and a second factory in which the first and second industrial equipments are installed, causing the first vendor to perform centralized maintenance management of the first industrial equipments installed in the first and second factories, and causing the second vendor to perform centralized maintenance management of the second industrial equipments installed in the first and second factories.

Further objects, features and advantages of the present invention will be apparent from the following description of embodiments of the present invention with reference to be accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of a remote maintenance system for an industrial equipment according to the firs embodiment of the present invention;

FIG. **2** is a flow chart showing the operation of a host computer serving as a monitor apparatus installed on the user (factory) side;

FIG. **3** is a flow chart showing the operation of a host computer serving as a management apparatus installed on the vendor side;

FIG. **4** is a flow chart showing an implementation to be taken by a person in charge in the department of maintenance;

FIG. **5** is a view showing an input window example serving as the user interface of a trouble database;

FIG. **6** is a view showing the arrangement of a communication security system;

FIG. **7** is a schematic view of a remote maintenance system for an industrial equipment according to the second embodiment of the present invention;

FIG. **8** is a flow chart showing a semiconductor device manufacturing flow; and

FIG. **9** is a flow chart showing a wafer process.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment of Remote Maintenance System for Industrial Equipment

FIG. **1** is a schematic view showing the remote maintenance system for an industrial equipment according to a preferred embodiment of the present invention. Reference numeral **101** denotes an office of a vendor (apparatus supply maker) for providing industrial equipments. This embodiment assumes, as industrial equipments, semiconductor manufacturing apparatuses used in semiconductor manufacturing factories. Examples of the semiconductor manufacturing apparatuses are preprocessing equipments (e.g., an

exposure apparatus, a coating/developing apparatus, and an annealing apparatus), and postprocessing equipments (e.g., an assembling apparatus and an inspection apparatus).

Reference numerals **102** to **104** denote production factories of at least one semiconductor manufacturing maker serving as the user of industrial equipments. That is, the production factories **102** to **104** may belong to different makers or one maker (e.g., preprocessing and postprocessing factories),

A plurality of industrial equipments **106**, a LAN (intranet) **109** for connecting these equipments **106**, and a host computer **107** serving as a monitor apparatus for monitoring the operating states of the respective industrial equipments **106** are arranged in each of the factories **102** to **104**.

The host computer **107** in each of the factories **102** to **104** is connected to a host computer **108** serving as the management apparatus on a vendor **101** side through the internet **105** serving as a worldwide communication means. The host computer **107** notifies status information (e.g., the state of the corresponding industrial equipment in trouble) representing the operating state of the corresponding industrial equipment **106** from the factory side to the vendor side. At the same time, the host computer **107** receives response information (e.g., information for instructing a countermeasure against the trouble, or a countermeasure program or its data) from the vendor side in response to the above notification. The status information and/or the response information will be referred to as maintenance information thereinafter.

In communication between the factories **102** to **104** and the vendor **101** and LAN communication in each factory, a packet communication protocol (TCP/IP) generally used in the internet is used.

The host computer **108** on the vendor **101** side can instantaneously grasp the operating states of the industrial equipments **106** in the user factories **102** to **104** through the internet **105**. The maintenance information representing the operating state and the maintenance state can be looked up from computers in other departments of the vendor **101**, e.g., computers **110** in the manufacturing department and the department of development in addition to the department of maintenance. The maintenance information can be fed back to the manufacturing department and the department of development.

FIG. **2** is a flow chart showing the operation of the host computer **107** installed in each factory. The host computer **107** periodically executes processing represented by this flow chart to periodically monitor the operating states of the plurality (n) of industrial equipments **106** through the LAN **109**. Upon occurrence of a trouble, the host computer **107** obtains status information such as the state of the trouble and notifies the vendor **101** side of them through the internet **105**.

In the flow chart of FIG. **2**, the host computer **107** identifies and manages the plurality of industrial equipments **106**, i.e., the monitor targets, as the first to nth industrial equipments. The host computer **107** sequentially increments a parameter i (steps **S207** and **S208**) and monitors the operating state of the ith industrial equipment (step **S203**). The host computer **107** obtains the status information about the operating state of an industrial equipment in trouble (step **S204**) and informs the vendor **101** side of this status information through the internet **105** (step **S205**). The host computer **107** automatically maintains the industrial equipment in trouble through the LAN **109**, if possible (e.g., the trouble can be eliminated by software updating or the like), on the basis of the response information transmitted from the vendor **101** side in response to the report of the status information (step **S206**). Note that if automatic maintenance against the trouble is impossible, a message representing this is displayed on, e.g., a display.

Each industrial equipment **106** has a function of notifying the corresponding host computer **107** of the presence/absence of a trouble in response to a request from the host computer **107** (corresponding to step **S203**), and a function of specifying the contents of the trouble and notifying the host computer **107** of the status information (e.g., an error code representing the contents of the trouble) representing the specified contents (corresponding to step **S204**).

In step **S205**, the status information notified from the host computer **107** to the vendor **101** side contains, e.g., the model of the industrial equipment in trouble, the serial number, the error code, and trouble occurrence time. The corresponding relationship between the error code and the contents of the trouble can be spontaneously updated from the host computer **108** of the vendor **101** side through the internet **105**.

If the contents of a trouble are not registered in advance, an error code representing this may be contained in the status information. In this case, the operator can notify the vendor side of detailed information by means of telephone, facsimile, or E-mail.

The host computer **108** serving as the management apparatus on the vendor **101** side waits for communication from the host computer **107** in each factory for, e.g., 24 hours. FIG. **3** is a flow chart showing the operation of the host computer **108** on the vendor **101** side.

The host computer **108** on the vendor **101** side periodically executes processing represented by the flow chart in FIG. **3** to monitor the operating states of the industrial equipments **106** of the respective factories **102** to **104**.

First, the host computer **108** monitors whether the report of a trouble is present (step **S302**). If YES in step **S302**, the host computer **108** obtains status information about this report (step **S303**). The host computer **108** looks up the trouble database (DB) for managing the maintenance of the industrial equipments of each factory on the basis of this status information. The host computer **108** checks whether the same trouble state as the currently reported trouble state for the same industrial equipment has occurred in the past, i.e., whether the same trouble state is registered in the trouble database (**501** to be described later) (step **S304**).

If the same trouble state is registered in the trouble database ("YES" in step **S304**), it is determined whether a countermeasure against this trouble state is registered (step **S306**). If YES in step **S306**, the host computer **108** notifies the host computer **108**, in the factory which has reported the trouble, of response information about the registered countermeasure (e.g., code information or message representing the countermeasure, a countermeasure program, or its data) through the internet **105** (step **S307**).

Upon reception of the response information, the host computer **107** on the factory side automatically restores the industrial equipment in trouble to a normal state, if possible. When such automatic restoration is impossible, the host computer **107** outputs a message to, e.g., a display for the operator of the industrial equipment in trouble.

The host computer **108** reports, to a person in charge on the vendor **101** side, the fact of occurrence of the trouble, the contents of the trouble (status information), the presence/absence of notification of the countermeasure (response information), the current state, and any other associated

information. This report is displayed on the display of the computer **110** and made by automatically transmitting an E-mail from the host computer **108** to the mail address of the person in charge on the vendor side.

If it is determined in step **S304** that the same trouble state as the currently reported trouble state is not registered in the trouble database, this trouble state is newly registered in the trouble database (step **S305**), and then step **S308** is executed.

When the report to the operator is complete (step **S308**), the host computer **108** updates the trouble database (step **S309**). By this updating, the presence/absence of transmission of the countermeasure (response information), trouble report reception time, and the like are registered in the trouble database.

FIG. **4** is a flow chart showing the flow of the implementation which can be taken by the person in charge in the department of maintenance, who has received the report in step **S308**. First, the person in charge looks up the trouble database to grasp the contents of a trouble and determines whether a countermeasure is required (step **S402**). If NO in step **S402** (e.g., when an appropriate countermeasure is notified to the corresponding factory in step **S307**), the operating state of the industrial equipment **106** in trouble is monitored through the internet **105** for, e.g., future occurrence of this trouble (step **S404**).

If, however, a countermeasure is required (i.e., "YES" in step **S402**), the person in charge selects an appropriate countermeasure by looking up the information stored in the trouble database (step **S403**).

As a countermeasure policy, the trouble can be eliminated on-line through the internet **105** (step **S407**). As an example, the trouble may be caused by a software error. In this case, the parameters and program in the memory of the industrial equipment in trouble may be corrected on-line through the internet **105** and the host computer **107** on the factory side.

As another countermeasure policy, a method of eliminating the trouble may be instructed to the operator by means of E-mail, facsimile, telephone, or the like (step **S406**).

For a serious trouble which cannot be eliminated by the methods in steps **S406** and **S407**, the person in charge visits the factory to eliminate the trouble (step **S405**).

When the countermeasure is complete, the person in charge operates the host computer **108** or the computer **110** to update the trouble database on the basis of the information associated with this trouble (step **S408**).

The trouble database in the host computer **108** on the vendor **101** side will be described below. Dedicated or general-purpose browser software is installed in each computer **110** connected to the host computer **108** through the LAN **109** and the console of the industrial equipment **106** of each factory connected through the internet, thereby constituting, e.g., the user interface window shown in FIG. **5**.

The operator on the vendor or factory side can input information such as the model (**401**) of the industrial equipment, the serial number (**402**), the case of trouble (**403**), the date of trouble occurrence (**404**), the emergency degree (**405**), the trouble state (**406**), the countermeasure (**407**), and progress (**408**). Note that information may be automatically input to the trouble database by the host computer **108**, as described above.

The browser software of the window shown in FIG. **5** has a hyperlink function (**410** to **412**) which allows each worker in each department of the vendor and each operator in each factory to access detailed information of each item, retrieve a new version of the software from the software library, or retrieve an operation guide (auxiliary information) as the reference for the operator in the factory.

As described above, the worker in each department on the vendor **101** side, such as the department of maintenance, the manufacturing department, and the department of development can access the trouble database by using the computer **110** connected to the host computer **108** through the LAN **109**. The outside maintenance personnel can also access the trouble database by using a portable terminal through the internet **105**. Therefore, the information of the respective departments of the vendor can be centralized and managed, and each department can always access the latest information.

Information as part of the trouble database can be disclosed to users (factories), and each user can access various kinds of past maintenance information through the internet and employs an appropriate countermeasure against his own trouble. As described above, in this embodiment, the maintenance information can be shared by the vendor and the plurality of users to remarkably improve the maintenance efficiency.

This embodiment also comprises a communication security system for inhibiting the third party from accessing confidential information from the trouble database through the internet.

This system has a fire wall to perform validation using a password, and a computer which is allowed to access the database is registered in the host computer **108** of the vendor **101** in advance, thereby inhibiting access by a computer other than the registered computers.

FIG. **6** is a view showing the arrangement of the communication security system according to this embodiment. Communication for accessing a trouble database **501** of the host computer **108** on the Vendor **101** side by using a browser **500** is performed using an encoded packet. The host computers **107** and **108** comprise codecs **502** and **504** and communication controllers **503** and **505**. A codec algorithm is provided in each factory (user) (the codecs on the vendor side can cope with a plurality of algorithms). The codec algorithms are periodically changed to improve security.

In the system of this embodiment, as described above, the internet serving as the exiting infrastructure and its communication protocol, and internet access software are used to communicate maintenance information of the industrial equipments. For this reason, loads on installation of dedicated communication lines and development of new software can be reduced, and a high-speed, low-cost remote maintenance system can be constructed.

The plurality of factories in which the industrial equipments are installed are connected to the vendor management system through a communicating means to perform centralized management of maintenance information and share the information. The experiences of the past troubles can be utilized beyond the production sites, thereby immediately coping with troubles. In particular, when maintenance information is shared by different business enterprises as users, the efficiency of the whole industry can be improved.

Second Embodiment of Remote Maintenance System for Industrial Equipment

FIG. **7** is a conceptual view of an industrial equipment maintenance system according to the second embodiment of the present invention. In the first embodiment, the plurality of user factories each having the industrial equipment are connected to the management system for the vendor for the

industrial equipment at through a communicating means, and the maintenance information of the industrial equipment of each factory is communicated through the communicating means. However, in the second embodiment, a factor having industrial equipments of a plurality of vendors is connected to the management systems of the vendors for the plurality of industrial equipments through a communicating means using the internet, thereby communicating maintenance information of each industrial equipment through the communicating means.

Referring to FIG. **7**, reference numeral **201** denotes a production factory of an industrial equipment user (semiconductor device manufacturing maker) in which an exposure apparatus **202**, a coating/developing apparatus **203**, and an annealing apparatus **204**, all of which serve as the semiconductor device manufacturing apparatuses, are installed in the production line of the factory. Only one production factory **201** is illustrated in FIG. **7**, but a plurality of factories are similarly networked in practice. The above apparatuses are connected through a LAN (intranet) **206**, and the operation of the line is managed by a production management host computer **205**. Host management systems **211**, **221**, and **231** for performing remote maintenance of the supply equipments are provided in the offices of the vendors (apparatus supply makers) such as an exposure apparatus maker **210**, a coating/developing apparatus maker **220**, and an annealing apparatus maker **230**. The host computer **205** for managing each apparatus in the production factory of the user is connected to the management systems **211**, **221**, and **231** of the vendors for the respective apparatuses through the internet **200**. As described with reference to FIG. **1**, each of the vendors **210**, **220**, and **230** can perform centralized maintenance management of its own supply apparatuses in the factories of the plurality of users.

In this system, when a trouble has occurred in one of the series of production equipments on the production line, the operation of the production line stops. Remote maintenance is received from the vendor for the equipment in trouble through the internet **200** to immediately cope with the trouble, thereby minimizing the stop period of the production line. The host management system of each vendor has a trouble database as described with reference to the first embodiment. Maintenance information is stored in this trouble database. Different communication security systems are used between the production factory and different vendors to prevent leakage of information. The detailed maintenance contents and method are identical to those of the first embodiment, and a detailed description thereof will be omitted.

As described above, in the system of this embodiment, a plurality of factories of one or a plurality of users, which have industrial equipments of the plurality of vendors on the production line are connected to the management systems of the respective vendors to communicate maintenance information. Even if a given equipment during production gets in trouble, immediate maintenance can be received from the corresponding vendor. The line stop time can be minimized to improve the production efficiency. In particular, when maintenance information is shared by different users, different business enterprises, or different vendors, the efficiency of the whole industry can be improved.

Embodiment of Semiconductor Device Production Method

A semiconductor device production method in a facility using the above-described remote maintenance system will be described below.

FIG. **8** is a flow of manufacturing microdevices (e.g., a semiconductor chip such as an IC or LSI, a liquid crystal panel, a CCD, a thin film magnetic head, and a micromachine). In step **1** (circuit design), circuit design for a semiconductor device is performed. In step **2** (mask formation), a mask on which the designed circuit pattern is formed. In step **3** (wafer preparation), a wafer using a material such as silicon is prepared. Step **4** (wafer process) is called a preprocess in which a circuit is actually formed on the wafer using lithography techniques by using the prepared mask and wafer. Step **5** (assembly) is called a postprocess of forming a semiconductor chip by using the wafer processed in step **4** and includes an assembly step (dicing and bonding) and a packaging step (chip sealing). In step **6** (inspection), inspections such as the operation check test and the durability test of the semiconductor device manufactured in step **5** are performed. Through these steps, the semiconductor device is finished. When the semiconductor device is shipped (step **7**), the preprocess and postprocess are performed in different dedicated factories, and maintenance is performed for each factory by the remote maintenance system described above.

FIG. **9** shows a flow of the wafer process in detail. In step **11** (oxidation), the surface of the wafer is oxidized. In step **12** (CVD), an insulating film is formed on the wafer surface. In step **13** (electrode formation), an electrode is formed on the wafer by deposition. In step **14** (ion implantation), ions are implanted in the wafer. In step **15** (resist process), the wafer is coated with a photosensitive agent. In step **16** (exposure), the circuit pattern of the mask is printed and exposed by the exposure apparatus. In step **17** (development), the exposed wafer is developed. In step **18** (etching), the nonexposed portion except the developed resist image is removed. In step **19** (resist removal), the unnecessary resist upon etching is removed. These steps are repeatedly performed to form a multiple of circuit patterns on the wafer. The production equipments used in the respectively steps are monitored by the remote maintenance systems described above. Troubles can be prevented in advance. Even if a trouble occurs, immediate restoration can be performed, thereby improving the productivity of semiconductor devices as compared with the conventional case.

As has been described above, according to the present invention, the worldwide internet is used as the remote maintenance communication means for the industrial equipments to allow construction of an effective maintenance system with less capital investment regardless of the installation locations of the equipments.

The user factories in which industrial equipments are installed are connected to the vendor management systems through the communicating means to immediately cope with troubles. In addition, when the maintenance information is shared, the maintenance capability can be expected to be improved.

The present invention is not limited to the above embodiments and various changes and modifications can be made within the spirit and scope of the present invention. Therefore, to apprise the public of the scope of the present invention the following claims are made.

What is claimed is:

1. A remote maintenance system for maintaining industrial equipment installed at a remote location, said system comprising:

monitor means for monitoring an operating state of the industrial equipment; and

management means for managing maintenance of the industrial equipment while in communication with said monitor means through an internet,

wherein, in the communication, said management means receives from said monitor means status information or the industrial equipment and transmits to said monitor means response information used for maintaining the industrial equipment in response to the received status information.

2. The system according to claim **1**, wherein said management means performs centralized maintenance management of a plurality of industrial equipment respectively installed in a plurality of factories.

3. The system according to claim **2**, wherein the plurality of factories are factories of at least one user, and said management means is arranged at a vendor site.

4. The system according to claim **1**, wherein a plurality of types of industrial equipment is installed in one factory, and said management means comprises a plurality of management units respectively corresponding to the plurality of types of industrial equipment.

5. The system according to claim **4**, wherein said plurality of types of industrial equipment is supplied by a plurality of different vendors, and said plurality of management units are arranged at the plurality of different vendors.

6. The system according to claim **1**, further comprising means for supplying at least one of software for the industrial equipment and guide information associated with an operation of the industrial equipment from said management means to the industrial equipment through the Internet.

7. The system according to claim **1**, wherein

said monitor means detects occurrence of trouble in the industrial equipment and notifies said management means of the status information for specifying a state of the trouble, and

said management means determines a countermeasure against the trouble in the industrial equipment based on the status information and informs said monitor means of the response information based on the determined countermeasure.

8. The system according to claim **7**, wherein said monitor means comprises maintenance means for maintaining the industrial equipment based on the response information received from said management means.

9. The system according to claim **7**, wherein

management means includes a database for registering information associated with maintenance of the industrial equipment, said database registering information for identifying an industrial equipment, trouble states that may occur in the identified industrial equipment, and corresponding countermeasures against the registered trouble states, and

said management means looks up a detected trouble state in the database to determine a corresponding countermeasure against the detected trouble state.

10. The system according to claim **9**, wherein said management means comprises automatic updating means for updating the database based on contents of the information associated with maintenance of the industrial equipment every time information associated with maintenance of the industrial equipment is exchanged with said monitor means.

11. The system according to claim **10**, wherein said management means further comprises manual updating means for updating the database based on input information from an operator.

12. The system according to claim **9**, wherein said management means further comprises access permission means for giving permission to a user of the industrial equipment to access the database.

13. The system according to claim **12**, wherein said management means further comprises communication security means for inhibiting a third party except the user of the industrial equipment from accessing the database.

14. The system according to claim **9**, wherein said monitor means comprises access means for accessing the database of said management means.

15. The system according to claim **1**, wherein the industrial equipment comprises a semiconductor manufacturing apparatus.

16. The system according to claim **1**, wherein said management means includes means for automatically transmitting the response information to said monitor means in response to the status information.

17. The system according to claim **1**, wherein the industrial equipment stores a browser software providing a user interface having a hyperlink function in a display that allows access to the internet.

18. The system according to claim **17**, wherein the browser software provides at least one of functions accessing a database on said management means that provides maintenance information of the industrial equipment, accessing a software library of the industrial equipment through the internet, and accessing an operation guide of the industrial equipment through the internet.

19. A method of manufacturing a semiconductor device using a semiconductor manufacturing apparatus, the method comprising the steps of:

monitoring an operating state of the semiconductor manufacturing apparatus using a monitor apparatus;

managing maintenance of the semiconductor manufacturing apparatus from a remote location using a management apparatus while the management apparatus is in communication with the monitor apparatus through an internet; and

executing at least one of an exposing process, a coating/developing process, an annealing process, an assembling process, and an inspection process using the maintained semiconductor manufacturing apparatus,

wherein, in the communication at said managing step, the management apparatus receives from the monitor apparatus status information of the semiconductor manufacturing apparatus and transmits to the monitor apparatus response information used for maintaining the semiconductor manufacturing apparatus in response to the received status information, and

the communication at said managing step is executed with a security system having at least one of a coded system providing an encoded communication and a fire wall.

20. The method according to claim **19**, said method further comprising the step of accessing the management apparatus through the internet with a browser software stored in a console of the semiconductor manufacturing apparatus.

21. The method according to claim **20**, wherein said browser software provides a user interface on a display that allows access to the internet, the user interface having a hyperlink function and capable of performing at least one of operations of accessing a database on the management apparatus that provides maintenance information of the semiconductor manufacturing apparatus, accessing software library of the semiconductor manufacturing apparatus through the internet, and accessing an operation guide of the semiconductor manufacturing apparatus through the internet.

22. The method according to claim **19**, further comprising installing a plurality of the semiconductor manufacturing apparatuses mutually connected with a LAN in a factory.

23. A semiconductor device manufactured by a method comprising the steps of:

monitoring an operating state of a semiconductor manufacturing apparatus using a monitor apparatus;

managing maintenance of the semiconductor manufacturing apparatus from a remote location by a management apparatus while the management apparatus is in communication with the monitor apparatus through an internet; and

executing at least one of an exposing process, a coating/developing process, an annealing process, an assembling process and an inspection process using the maintained semiconductor manufacturing apparatus,

wherein, in the communication at said managing step, the management apparatus receives from the monitor apparatus status information of the semiconductor manufacturing apparatus and transmits to the monitor apparatus response information used for maintaining the semiconductor manufacturing apparatus in response to the received status information, and

the communication in said managing step is executed with a security system having at least one of a coded system providing an encoded communication and a fire wall.

24. The device according to claim 23, wherein the method further comprises accessing the management apparatus through the internet with a browser software stored in a console of the semiconductor manufacturing apparatus.

25. The device according to claim 24, wherein said browser software provides a user interface on a display that allows access to the internet, the user interface having a hyperlink function and capable of performing at least one of operations of accessing a database on the management apparatus that provides maintenance information of the semiconductor manufacturing apparatus, accessing software library of the semiconductor manufacturing apparatus through the internet, and accessing an operation guide of the semiconductor manufacturing apparatus through the internet.

26. The device according to claim 23, further comprising installing a plurality of the semiconductor manufacturing apparatuses mutually connected with a LAN in a factory.

27. A monitor apparatus arranged on an industrial equipment side for use in a remote maintenance system for maintaining industrial equipment installed at a remote location, said monitor apparatus comprising:

obtaining means for detecting occurrence of trouble in the industrial equipment and obtaining status information representing a state of the trouble;

communication means for notifying, through an internet, a management apparatus that performs centralized maintenance management of the industrial equipment of status information obtained by said obtaining means, and for receiving response information used for maintaining the industrial equipment sent from the management apparatus, through internet, in response to notification of the status information, and

maintenance means for maintaining the industrial equipment based on the response information received by said communication means from the management apparatus.

28. The apparatus according to claim 27, wherein the industrial equipment comprises a plurality of manufacturing apparatuses mutually connected with a LAN in a factory, and said obtaining means detects the occurrence of trouble in each apparatus.

29. The apparatus according to claim 28, wherein the industrial equipment comprises a semiconductor manufacturing apparatus.

30. A management apparatus provided by a vendor for use in a remote maintenance system for maintaining industrial equipment for manufacturing installed in a user factory, said management apparatus comprising:

a communication system for communicating, thorough an internet, with a respective monitor apparatus installed in the factory in which the monitor apparatus is arranged to monitor an operating state of the industrial equipment during operation; and

a computer system for deteimining a countermeasure against trouble in the industrial equipment based on status information received by said communication means from the monitor apparatus, and causing said communication system to notify the monitor apparatus of response information based on the determined countermeasure, wherein the status information is associated with a state of the trouble in the industrial equipment.

31. The management apparatus according to claim 30, further comprising a database for registering information associated with maintenance of industrial equipment, said database registering information for identifying industrial equipment, trouble states that may occur in the identified industrial equipment, and corresponding countermeasures against the registered trouble states,

wherein said corresponding means looks up a detected trouble state in the database to determine a corresponding countermeasure against the detected trouble state.

32. The apparatus according to claim 31, further comprising manual updating means for updating the database based on input information from an operator.

33. The apparatus according to claim 30, further comprising automatic updating means for updating a database based on contents of the information associated with maintenance of the industrial equipment every time information associated with maintenance of the industrial equipment is exchanged with the monitor means.

34. The apparatus according to claim 30, further comprising access permission means for giving permission to a user of the industrial equipment to access a database.

35. The apparatus according to claim 34, further comprising communication security means for inhibiting a third party except the user of the industrial equipment from accessing the database.

36. The apparatus according to claim 30, wherein the industrial equipment comprises a semiconductor manufacturing apparatus.

37. A remote maintenance method of maintaining industrial equipment installed at a remote location, comprising the steps of:

communicating, through an internet, maintenance information between a first vendor that supplies first industrial equipment, a second vendor that supplies second industrial equipment, a first factory in which the first and second industrial equipment are installed, and a second factory in which the first and second industrial equipment are installed;

causing the first vendor to perform centralized maintenance management of the first industrial equipment installed in the first and second factories; and

causing the second vendor to perform centralized maintenance management of the second industrial equipment installed in the first and second factories,

wherein the maintenance information includes status information of the first or second industrial equipment and response information, sent in response to the status information, used for maintaining the first or second industrial equipment.

38. The method according to claim **37**, wherein the first and second factories are factories of a single user or multiple different users.

39. The apparatus according to claim **38**, wherein the industrial equipment comprises a semiconductor manufacturing apparatus.

40. A remote maintenance method for industrial equipment for manufacturing installed in a factory, comprising the steps of:

providing a database accessible through an internet, the database storing maintenance information of the industrial equipment;

allowing a limited user of the industrial equipment installed in the factory to access the database through the internet with a security system for handling trouble associated with the industrial equipment, the security system having at least one of a coded system providing an encoded communication and a fire wall; and

updating the maintenance information on the database so as to reflect the trouble.

41. The method according to claim **40**, wherein the database stores information for identifying industrial equipment, trouble states that may occur in the identified industrial equipment, and corresponding countermeasures against the registered trouble states.

42. The method according to claim **40**, further comprising the step of automatically notifying an appropriate personnel of the trouble with the industrial equipment.

43. The method according to claim **42**, wherein said notifying step comprises automatically sending an e-mail to the appropriate personnel.

44. The method according to claim **40**, wherein the industrial equipment comprises a semiconductor manufacturing apparatus and maintenance information comprises trouble information of the semiconductor apparatus.

45. A semiconductor manufacturing apparatus for manufacturing semiconductor devices, comprising:

a network connector;

a console having a display; and

a browser software providing a user interface on the display that allows access to an internet, the user interface having a hyperlink function and capable of performing at least one of operations of accessing a database through the internet that provides maintenance information of the apparatus, accessing software library of the apparatus through the internet and accessing an operation guide of the apparatus through the internet.

46. The apparatus according to claim **45**, wherein the database stores information for identifying a semiconductor manufacturing apparatus, trouble states that may occur in the identified semiconductor manufacturing apparatus, and corresponding countermeasures against the registered trouble states.

47. The apparatus according to claim **45**, wherein the semiconductor manufacturing apparatus comprises at least one of an exposure apparatus, a coating/developing apparatus, an annealing apparatus, an assembling apparatus and an inspection apparatus.

48. A semiconductor device manufacturing method comprising the steps of:

installing a semiconductor manufacturing apparatus in a factory for semiconductor manufacture;

monitoring the apparatus during operation to obtain status information of the apparatus;

consulting a database storing information of the apparatus in order to obtain response information corresponding to the status information;

executing an appropriate countermeasure for the monitored semiconductor manufacturing apparatus in the factory according to the response information, wherein at least one of said monitoring step, said consulting step and said executing step utilizes an internet to transmit information; and

performing a semiconductor manufacturing process with the apparatus.

49. The method according to claim **48**, wherein said installing step comprises installing a plurality of semiconductor manufacturing apparatuses in the factory mutually connected with a LAN, for semiconductor manufacture, and the database stores information for identifying each of the semiconductor manufacturing apparatuses, registered trouble states that may occur in the identified apparatuses, and corresponding countermeasures against the registered trouble states.

50. The method according to claim **48**, wherein said executing step comprises automatically notifying an appropriate personnel of trouble with the semiconductor manufacturing apparatus.

51. The method according to claim **50**, wherein said executing step further comprises automatically sending an e-mail to the appropriate personnel.

52. The method according to claim **48**, wherein the semiconductor manufacturing apparatus is one of an exposure apparatus, a coating/developing apparatus, an annealing apparatus, an assembling apparatus and an inspection apparatus.

53. A remote maintenance method for industrial equipment, said method comprising the steps of:

monitoring the industrial equipment installed in a factory during operation to obtain status information of the industrial equipment;

consulting a database storing information of the industrial equipment in order to obtain response information corresponding to the status information; and

executing an appropriate countermeasure for the industrial equipment in the factory according to the response information, wherein at least one of said monitoring step, said consulting step and said executing step utilizes internet.

54. The method according to claim **53**, further comprising a step of updating the information on the database after said consulting step.

55. The method according to claim **53**, wherein the database stores information for identifying industrial equipment, trouble states that may occur in the identified industrial equipment, and corresponding countermeasures against the registered trouble states.

56. The method according to claim **53**, wherein the database is managed by a vender who provides the industrial equipment.

57. The method according to claim **53**, wherein the database is managed by a user who uses the industrial equipment.

58. The method according to claim **53**, wherein said monitoring step comprises receiving the status information from the industrial equipment during operation through the internet.

59. The method according to claim 53, wherein said consulting step comprises sending the status information to the database through the internet and receiving the response information from the database through the internet.

60. The method according to claim 53, wherein said execution step comprises performing remote maintenance of the industrial equipment through the internet.

61. The method according to claim 53, wherein said execution step comprises notifying an appropriate personnel through the internet.

62. The method according to claim 61, wherein said executing step further comprises automatically sending to the appropriate personnel an e-mail about trouble with the industrial equipment.

63. The method according to claim 53, wherein the industrial equipment comprises a semiconductor manufacturing apparatus for manufacturing semiconductor devices.

64. A method according to claim 63, wherein the semiconductor manufacturing apparatus is one of an exposure apparatus, a coating/developing apparatus, an annealing apparatus, an assembling apparatus and an inspection apparatus.

65. A method for reporting trouble of industrial equipment, the method comprising the steps of:

monitoring industrial equipment including a first manufacturing apparatus and a second manufacturing apparatus installed in a factory during operation;

determining whether or not trouble associated with the first manufacturing apparatus or the second manufacturing apparatus has developed; and

automatically sending a report to a first vendor of the first manufacturing apparatus when the trouble has developed in the first manufacturing apparatus, and automatically sending a report to a second vendor of the second manufacturing apparatus when the trouble has developed in the second manufacturing apparatus.

66. The method according to claim 65, wherein the report is sent by an e-mail through an internet.

67. The method according to claim 65, wherein the industrial equipment comprises a semiconductor manufacturing apparatus for manufacturing semiconductor devices.

68. A method according to claim 67, wherein the semiconductor manufacturing apparatus is one of an exposure apparatus, a coating/developing apparatus, an annealing apparatus, an assembling apparatus and an inspection apparatus.

69. A semiconductor manufacturing factory, comprising:

a first semiconductor manufacturing apparatus provided by a first vendor;

a second semiconductor manufacturing apparatus provided by a second vendor;

a host computer capable of accessing an internet; and

an intranet having a LAN connecting the first and the second semiconductor manufacturing apparatuses and the host computer,

wherein the host computer allows communication between first semiconductor manufacturing apparatus and the first vendor through the internet for maintenance of the first semiconductor manufacturing apparatus, and allows communication between the second semiconductor manufacturing apparatus and the second vendor through the internet for maintenance of the second semiconductor manufacturing apparatus.

70. The factory according to claim 69, wherein each of the first and second semiconductor manufacturing apparatuses comprises one of an exposure apparatus, a coating/developing apparatus, an annealing apparatus, an assembling apparatus and an inspection apparatus.

71. The factory according to claim 70, wherein said communication is executed with a data security system.

72. The factory according to claim 69, wherein each one of the first and the second semiconductor manufacturing apparatuses comprises a console capable of performing at least one of operations of accessing a database through the internet that provides maintenance information of the apparatus, accessing software library of the apparatus through the internet and accessing an operation guide of the apparatus through the internet.

73. The factory according to claim 72, wherein said console comprises a display and browser software providing a hyperlink-type user interface on the display for the operations.

74. The factory according to claim 72, wherein said communication is executed with a data security system.

75. The factory according to claim 73, wherein said communication is executed with data security system.

76. The factory according to claim 69, wherein said communication is executed with a data security system.

77. A semiconductor manufacturing method, comprising:

installing a first semiconductor apparatus provided by a first vendor;

installing a second semiconductor manufacturing apparatus provided by a second vendor;

installing an intranet having a LAN connecting the first and second semiconductor manufacturing apparatuses and a host computer capable of accessing an internet;

executing communication between first semiconductor manufacturing apparatus and the first vendor through an internet for maintenance of the first semiconductor manufacturing apparatus while manufacturing semiconductor devices; and

executing communication between the second semiconductor manufacturing apparatus and the second vendor through the internet for maintenance of the second semiconductor manufacturing apparatus.

78. The method according to claim 77, further comprising:

providing a hyperlink-type user interface or a display provided with the semiconductor manufacturing apparatus; and

allowing an operator to access the internet using the hyperlink-type user interface in order to obtain maintenance information of the apparatus from the vendor.

79. The method according to claim 78, wherein the hyperlink-type user interface provides at least one of operations of accessing a database through the internet that provides maintenance information of the apparatus, accessing software library of die apparatus through the internet and accessing an operation guide of the apparatus through the internet.

80. The method according to claim 78, wherein said communication is executed with a data security system.

81. The method according to claim 79, wherein said communication is executed with a data security system.

82. The method according to claim 77, wherein said communication is executed with a data security system.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,385,497 B1
DATED : May 7, 2002
INVENTOR(S) : Nobuaki Ogushi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [74], *Attorney, Agent, or Firm,* "Fitzpatrick Cella Harper & Scinto" should read -- Fitzpatrick, Cella, Harper & Scinto --.
Item [57] **ABSTRACT**,
Line 2, "equipments" should read -- equipment --.

Column 1,
Lines 18, 33, and 39, "equipments" should read -- equipment --.

Column 2,
Line 30, "firs" should read -- first --.

Column 7,
Line 1, "at" should be deleted.

Column 10,
Line 46, "coded" should read -- codec --.

Column 11,
Line 22, "coded" should read -- codec --.

Column 12,
Line 8, "thorough" should read -- through --.

Column 13,
Line 22, "coded" should read -- codec --.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,385,497 B1
DATED : May 7, 2002
INVENTOR(S) : Nobuaki Ogushi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 16,
Line 22, "with" should read -- with a --.
Line 57, "die" should read -- the --.

Signed and Sealed this

Twenty-eighth Day of January, 2003

JAMES E. ROGAN
Director of the United States Patent and Trademark Office